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# (12) UK Patent Application (19) GB (11) 2 241 746 (13) A

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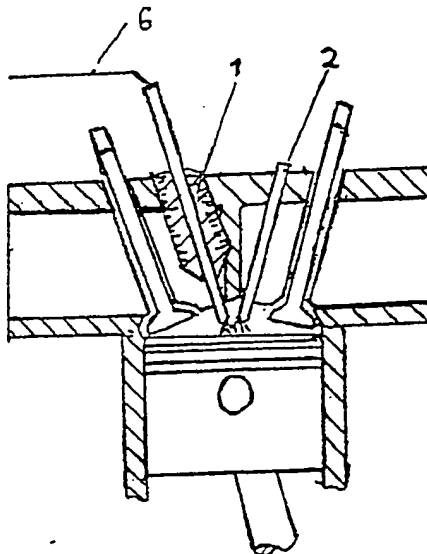
(56) Documents cited  
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UK CL (Edition K) F1J JBX, F1Q QGC, F1S

## (54) Method of energising a working fluid and deriving useful work

(57) An electric arc, or laser beam or other electrically induced medium is passed through a working fluid in order to energise it. The electrical energy required to initiate agitation of the molecules may be produced either by, a generator mounted on the device in which the energisation takes place or be provided from a separate source. The device may comprise a piston reciprocating in a cylinder (Fig 1) in which electrodes 1, 2 (Fig 2) energise air within the cylinder. Details of an electrical generator, variable resistor, switching mechanism and cabling for supplying the electrodes are disclosed. Alternatively the device may comprise a gas turbine engine (Fig 4) having a compressor C-C, a power turbine pt, a slave turbine st, reduction gear 7, electrodes 1, 2, generator 3 and variable resistor 4. Also disclosed is a device (Fig 5) in which the electrodes (1,2) convert water into steam to drive turbines (T, T<sub>2</sub>).

FIG 2



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FIG 1

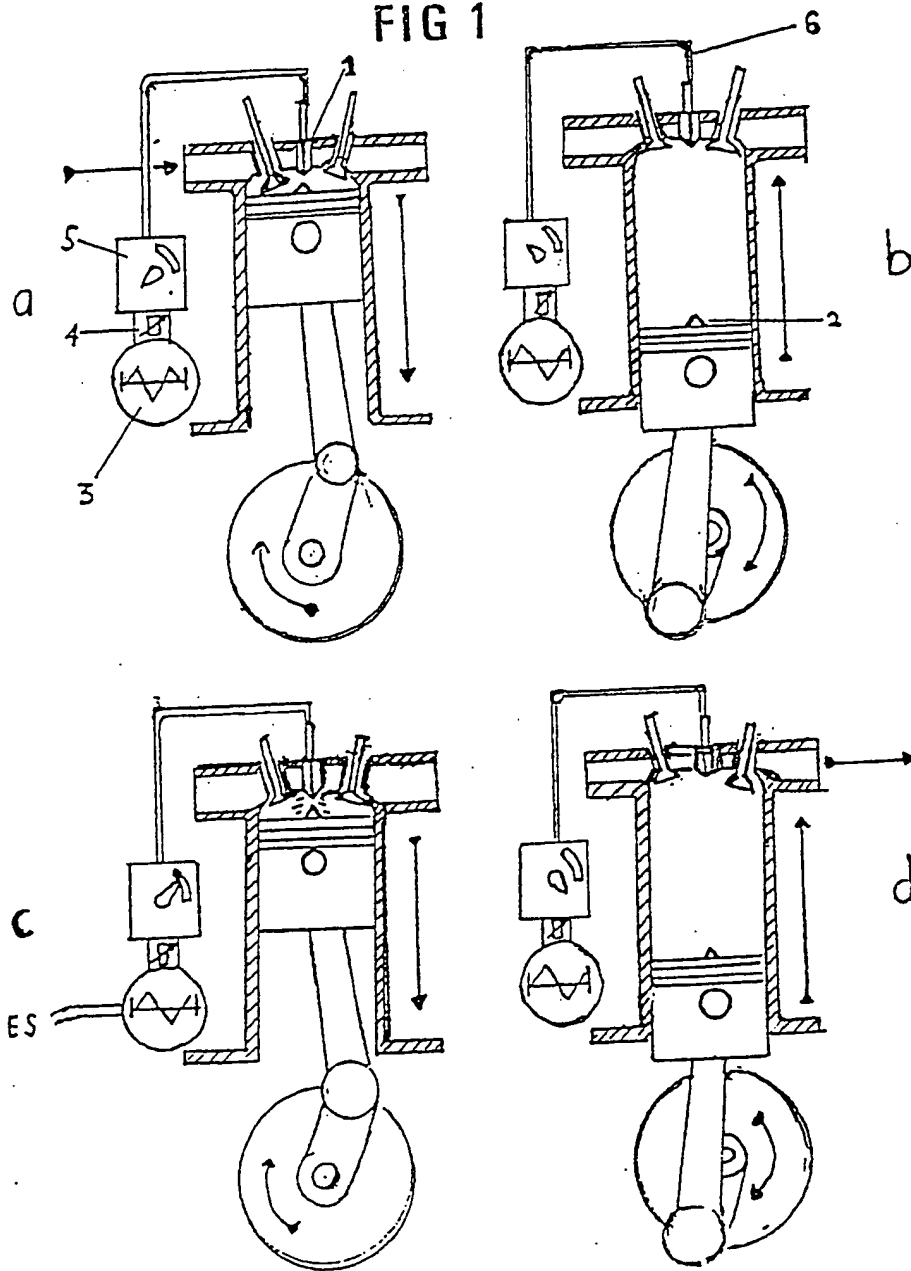


FIG 2

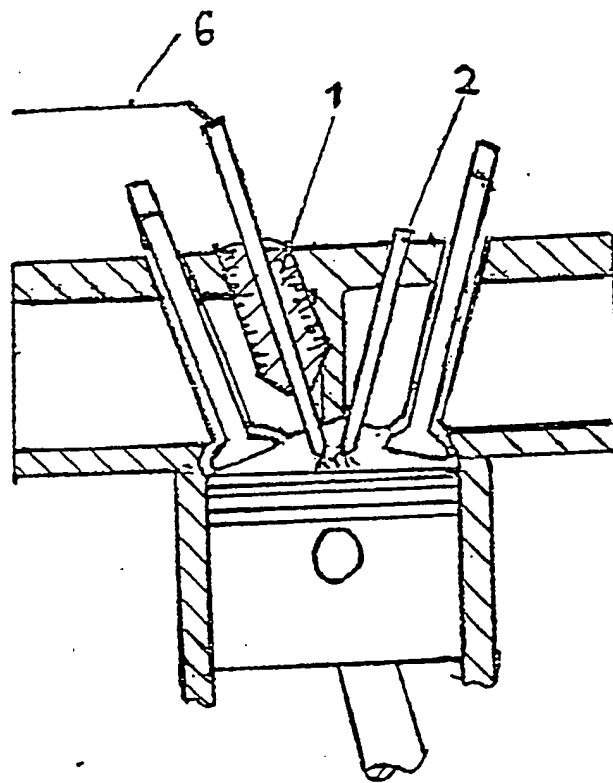
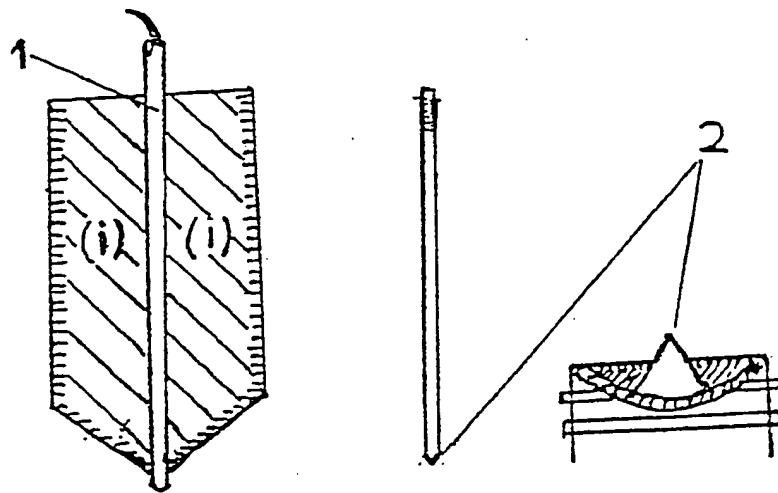
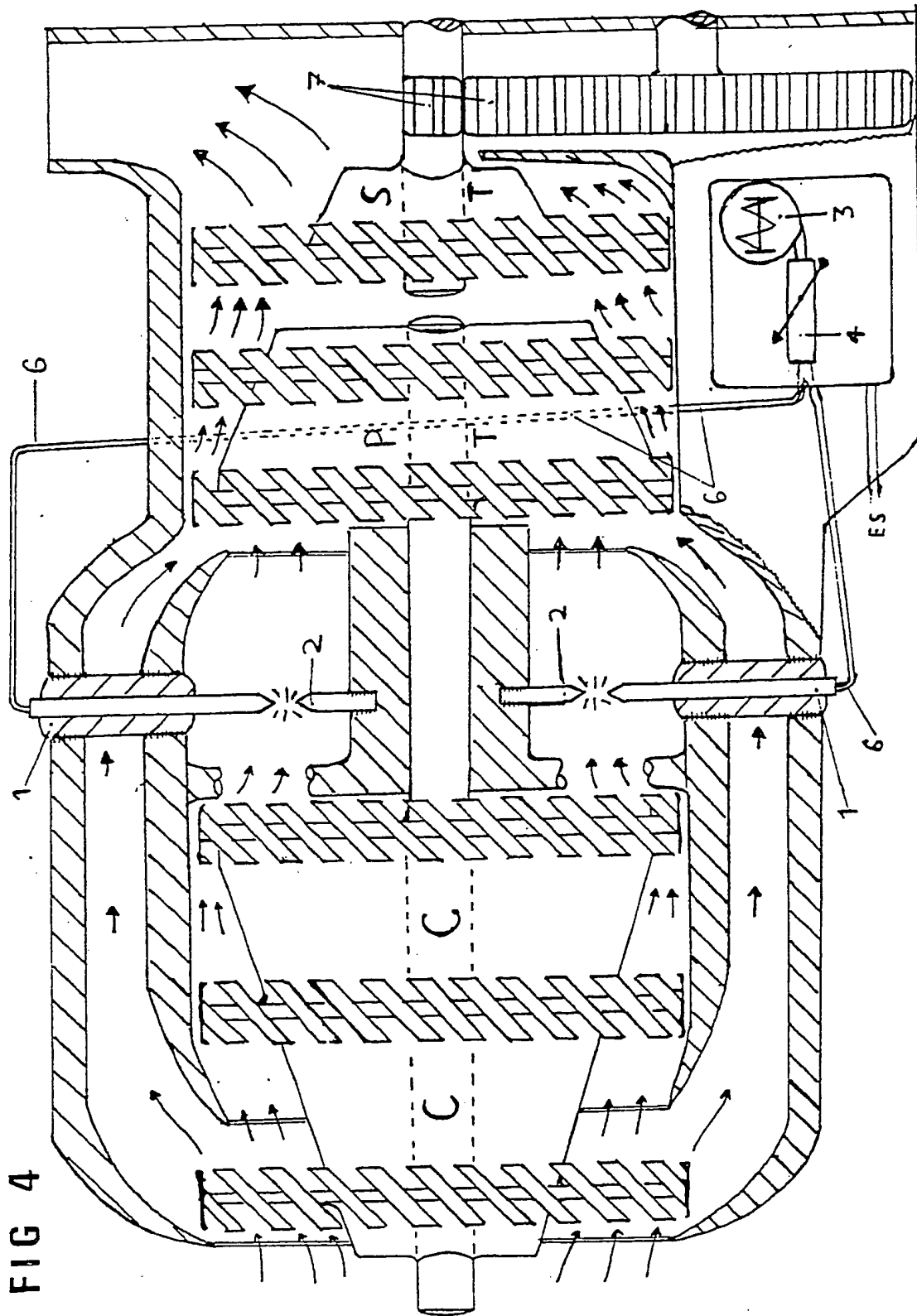
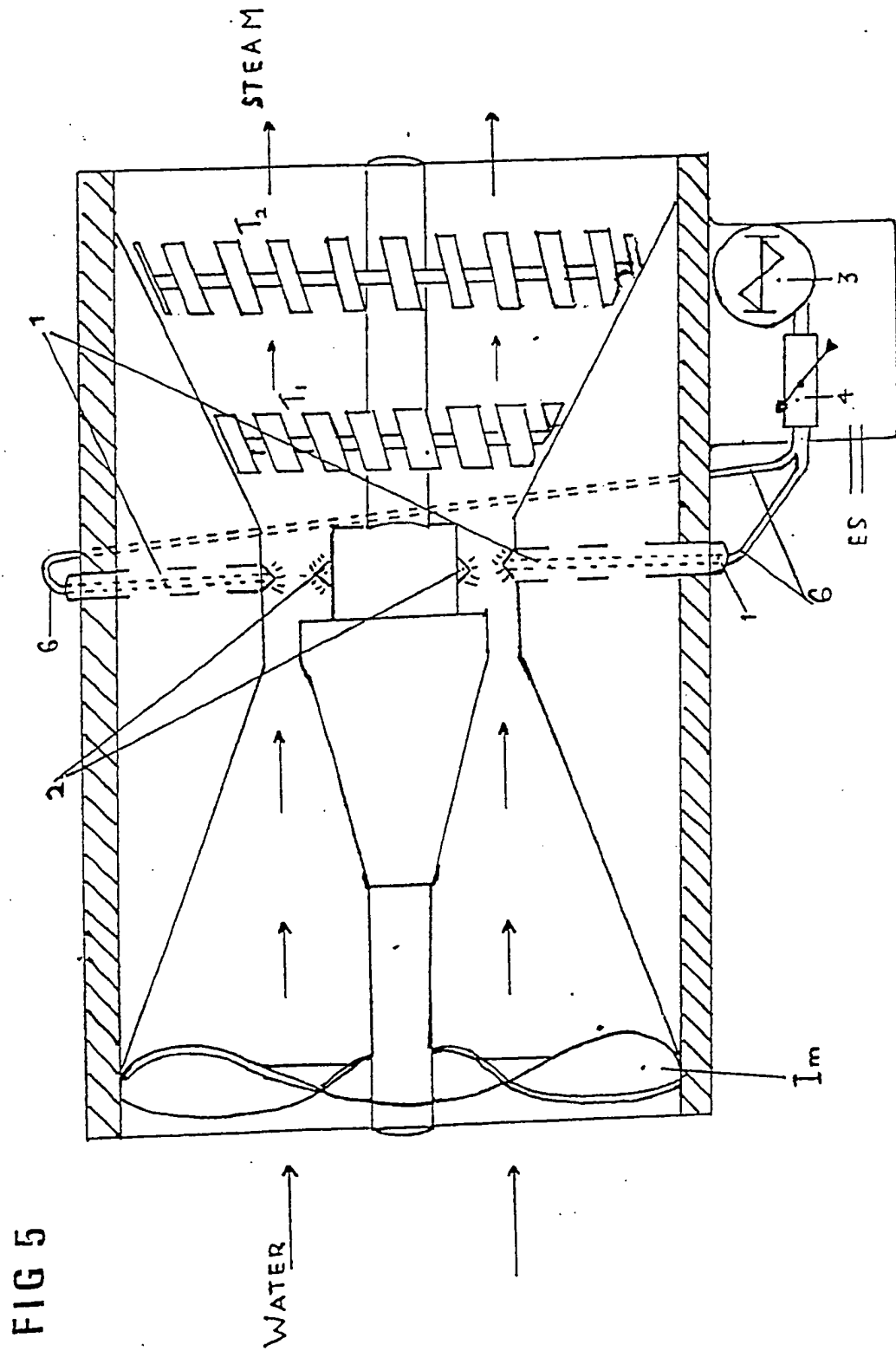


FIG 3







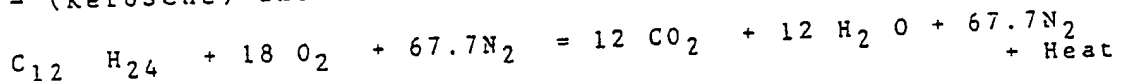
# AN ALTERNATIVE METHOD OF ENERGISING A WORKING FLUID

This invention relates to heating and expansion of various types of liquid and gaseous fluids, causing them either to do useful work or transmit generated heat. The latter being achieved by radiation or convection.

Heating working fluids has for centuries been a widely practised art for the transmission of heat for both warming and cooling purposes and latterly for the exploitation of potential energy. Among some of the most common examples today are, for heating/cooling: circulation of central heating systems, air duct heating and water or air cooling for engines. For energy: steam engines and turbines and the many types of internal combustion engines. Nuclear reactors apart, the most widely used method of heating fluids is by burning or combustion. This is a chemical reaction which involves oxidising a Hydro-Carbon fuel in, either solid, liquid or gas state, allowing the hydrogen and carbon molecules to combine with the oxygen molecules in normal air or an artificial oxygen rich atmosphere. This will cause heat to be given off and is therefore called an 'Exothermic' reaction.

The object of this invention is to show how heat may be generated by means other than combustion. In order to show how this is achieved it is necessary to briefly examine what happens during combustion.

When any hydro-carbon is burned in air or oxygen, the hydro-carbon molecules dissociate from each other. If the process is complete the carbon molecules may divide into smaller ones and combine with some of the oxygen molecules to form carbon dioxide (CO<sub>2</sub>). The remaining oxygens (O<sub>2</sub>) will divide into their atomic state (O) and will combine with the available hydrogen molecules to form water (H<sub>2</sub>O). A typical example of a chemical equation representing combustion is the one for the burning of Aviation Paraffin - (Kerosene) and is as follows:-





Anyone skilled in the art of assessing such an equation will quickly see that in spite of the heat gain on the right hand side, the molecular value balances on both sides of the equation, therefore although their atomic structure may have changed, none of the molecules have been consumed or destroyed in the reaction. Furthermore, the Nitrogen ( $67.7\text{N}_2$ ) has not taken any active part in the process but has produced indirectly some of the heat.

One of the reasons why heat and consequently expansion occurs is because in order to combine with each other, the carbon, hydrogen and oxygen molecules have divided themselves (e.g. some of the  $\text{O}_2$  s have become Os in order to combine with the  $\text{H}_2$  molecules, which themselves have separated from the  $\text{H}_{24}$  s). This has meant that the molecular bonds have been broken and re-combined to form the different molecules. The breaking and subsequent re-combination has released part of the heat energy. Also when the molecules reform it causes a collision between them and this has a literal 'knock on effect' with the other surrounding inert molecules (e.g. the  $67\text{N}_2$  s) particularly when the oxygen molecules are interdispersed among the inerts and the hydro carbon fuel is either sprayed or mixed in with the air charge so that its molecules are also interdispersed. This caused the inert molecules to agitate and in so doing they also produce some of the heat, albeit indirectly.

This is very interesting, for if we accept the fuel to air ratio of a typical combustion process as 1:13 or 7.7% (which is a quite common ratio) and note that the oxygen to inert gas ratio is approximately 21% : 79%, we can assume that no more than 30% of the molecules have caused the remaining 70% of the molecules to agitate (as well as agitating themselves) by more than just the convection of heat.

In view of the fact that energy is considered unable to be either created or destroyed, this should be viewed as a significant exploitation of potential energy and noted in conjunction with the fact that whenever a gas is compressed as in an internal combustion engine it is already partly energised.

During most types of combustion coloured flames are visible and the colour of the flame often denotes the type and temperature of the process. For example, when coal, oil or even petrol are burned in air at normal atmospheric pressure the flame is almost always yellow. This often

denotes an excess of carbon resulting in incomplete burning and can cause dry carbon in the form of soot and carbon monoxide (CO) to be given off instead of carbon dioxide.

This state of the process means that temperatures may only reach a maximum of  $450^{\circ}$  -  $500^{\circ}$  degrees C ( $842^{\circ}$  -  $932^{\circ}$  F). Since it is generally accepted as we have just seen that the heat is the result of both the Breaking/Recombination of the molecular bonds of the reactive molecules and the indirect agitation of the inert molecules it must be accepted that this state and colour or flame does not result in either complete reaction or maximum agitation of the molecules.

Sulphur impurities in coal and poorly refined diesel oil will oxidise at relatively low temperatures producing toxic sulphur dioxide ( $\text{SO}_2$ ) further inhibiting the potential energy output. A vivid red flame may show the presence of other impurities. A green flame indicates locally rich areas of hydro-carbon where there is insufficient oxygen to complete the reaction, thus only moderate temperatures are produced.

A blue flame, however, denotes almost complete if not complete combustion whereby all the hydro carbons are able to associate with the available oxygen. With this flame we can assume that both maximum reaction and agitation of the molecules has occurred and temperatures in this state are known to reach as high as  $1900^{\circ}$  C ( $3452^{\circ}$  F). This is very significant and will be referred to when the alternative method of energising a fluid is discussed. It is important to note though that whenever the temperature approaches  $1900^{\circ}$  C the carbon dioxide and water molecules begin to dissociate thus absorbing some of the energy initially produced by the reaction. This results in diminishing net energy output.

A further disadvantage of combustion is that it can never be carried out directly in water or any other inert liquid, i.e. water as a working fluid or heat transporter can never be directly energised by combustion unlike air. Therefore, if water is to be converted into steam or merely heated in its liquid state it has to be put into a containing vessel and any heat energy from a combustion process is transmitted to it, through the vessel. Since there are bound to be losses both to the vessel and the surrounding air this method can be said to be relatively inefficient.

There are also other disadvantages to our environment which could result from a continual increase in combustion processes but it is not the object of the present invention to discuss these.

The significance of the fact that maximum reaction molecular agitation is denoted in combustion by a blue flame will be apparent when it is also noted that, one of the suggested alternative methods of energising a working fluid, pertinent to the present invention also produces a blue coloured area of activity. The electric arc has been visible in many places ever since electricity was discovered. The colour though is more of a silver blue. It often appears for example across switch terminals when the switch is opened or closed and is used in various types of gas lighters.

More importantly, however, as far as the present invention is concerned it is used in the process of electric welding. One particular type of arc welding is Tungsten Inert Gas where the electrode, a tungsten rod, is capable of withstanding the very high temperatures involved and consequently is not melted or consumed in the process. The inert gas plays no active part in the actual welding and is only there to prevent the metal from oxidising. The temperature produced by the arc may be as high as  $4000^{\circ}\text{C}$  ( $7232^{\circ}\text{F}$ ) and it must also have a very high calorific (or British Thermal Unit) value. For not only is the cold solid metal transformed to a molten liquid, but a metallic vapour is also produced, often in less than two seconds. Whereas an oxy-acetylene torch takes into the tens of seconds to do the same thing, albeit that acetylene burning in oxygen produces some of the highest combustion temperatures known. Probably, the main reason for the much higher temperature is that the large current acts directly on the electrons in the atoms forming all the molecules in the metal and surrounding air or inert gas. This means that all the molecules would be activated and not just 30% directly and 70% indirectly activated, as has already been shown in the combustion process. Also the agitation of the molecules caused by an electrifying effect would be vigorous.

It is a prime objective therefore of this present invention, to show that if an electric arc or some other electrically induce medium was to be struck in already partly energised compressed air or inert gas, further energy would be realised when the gas subsequently heated and expanded rapidly enabling useful work to be done. The use of any potentially volatile gas would, however, be

outside the scope of the invention for, it might constitute a prior art. The difficulty of compressed air being a poor conductor of electricity could be overcome by one or either a combination of both of two ways. Firstly, by using a Very High Frequency or Ultra High Frequency generated current, which could have greater penetrating properties into the gas molecules, particularly if the molecules were in a linear or swirling motion whilst under compression. These currents could, for example, be of such a high frequency as to cause a partial rupturing of the molecular bonds, as we have seen with combustion this would cause greater values of energy to be released. It is assumed that the voltage and amperage would be determined proportionally to the volume and pressure of the gas under compression and that an increase/decrease in amperage would cause increases or decreases in the effect of the arc on the expansion of the gas. Secondly, the compressed gas could either be injected or sprayed with atomised water or steam, which would greatly improve its electrical conductivity properties.

In a petrol engine the current required to produce the spark to initiate combustion is, one of very high voltage and very low amps. The voltage may be as high as  $V \times 10^5$ , while the amperage may be measured in miliamps i.e.,  $I \times 10^{-3}$ . In the present invention, however, it is envisaged that the current required for the arc will be very different; the voltage being measured in decca volts ( $V \times 10$ ) or possible hecta volts ( $V \times 10^2$ ) while the amperage would be similarly measurable but only in  $I \times 10^2$  for very large applications. such a current, even for an average engine or power unit, would be fatal to persons or animals. Therefore, care would have to be taken that any terminals of cables transmitting the current to the electrode/s could never be exposed while current was being generated, especially during servicing or maintenance of the unit. If a current of these strengths was required it would mean that the power required for the current, if measured in watts, would be in units of kilowatts, i.e.  $W \times 10^3$ . But since the power output of even the average car engine is often as high as 85 KW (approx. 114 BHP) i.e. tens approaching hundreds of kilowatts there is no reason why at least some of the electric current required could not be produced by a generator driven by the engine, particularly in view of the fact, as shown previously, that the overall temperature and consequently the energy output, could be higher than a comparable internal combustion system.

Such an alternative method of energising compressed air or gas would be very beneficial, providing the gas was one which did not change its state and become toxic after being

acted upon by an electric arc. Air would not do this unless the temperature was so high that the nitrogen oxidised to form Nitro-oxide and subsequently in sunlight Nitro-dioxide ( $\text{NO}_2$ ). The only other difficulty to be overcome would be, to ensure that the electrodes used were made of a material that would not melt or oxidise in the very high temperatures and yet be a good electrical conductor. Also any engines built to incorporate the present invention would have to be manufactured from materials which would withstand the much higher temperatures of the electric arc. But with the progress now being made in the development of ceramics this should be quite possible. If all these requirements were met energy could be produced without any pollution or radiation. Any additional electrical current input required, (shown as E/S in all drawings), could come from an external source.

The basic principle could be applied to any thermo dynamic cycle and Fig 1 shows how it may be applied to the reciprocating four stroke piston type engine. Although in practical terms it may be too difficult to use the present invention on a reciprocating piston type engine. Nevertheless, the theory will be shown and practical difficulties highlighted after. Since the standard parts of this engine are already well known, only the parts necessary to apply the present invention to the engine have been listed and numbered.

Part 1, is the first of two opposing electrodes. This is the non earthed electrode that is, the one that is connected directly to the V.H.F./U.H.F. current supply (whether engine mounted generator or outside supply). Assuming the material from which the engine is manufactured is electrically conductive, this electrode will have to be very well insulated. An enlarged view of it is shown in FIG 3, with insulation shown as (i).

Part 2, is the opposing electrode and in this particular arrangement is placed in the crown of the piston. The reason for this will be explained when describing the cycle of operation. An alternative arrangement is shown in FIG 2 and enlarged views of both versions are also shown in FIG 3.

If the engine is made of electrically conductive material, this electrode will be directly connected to a return path to the generator. If the material is not electrically conductive though, provision will have to be made for a

return connection. This might be difficult if the return electrode is positioned in the crown of the piston, therefore, the alternative fixed position shown in FIG 2, may have to be used.

Part 3, is the integrally mounted generator (if employed) which would supply the V.H.F./U.H.F. current. One problem that would have to be overcome when an integrally mounted generator was employed would be the fact that, the frequency of any current generated is determined by the speed of rotation of the generator. Thus, if the speed of rotation of the engine and therefore, the generator varied, so would the frequency of the current produced. This may not be desirable since it has already been established that a constant V.H.F./U.H.F. current would be required to penetrate the compressed gas.

There are, however, two possible solutions to this problem. The first is to provide drive to the generator via a complex Mechanical, Pneumatic or Hydraulic compensating gear which would ensure that the generator would run at a constant speed regardless of the speed of the engine. The other would be, to transduce the varying frequency signal of the generator current using a capacitor/oscillator circuit into a constant V.H.F./U.H.F. signal, the varying speed of the generator would then be irrelevant. This principle is often used in electronic engineering.

Part 4, is a variable resistor which, when operated by a suitable governing device would act as a 'throttle' since a larger amount of current would be required to cause the engine to accelerate than when running at a constant speed and a lesser amount would result in deceleration.

Part 5, is a switching mechanism, which if driven at half engine speed in the four stroke cycle will ensure that the current would only flow at the particular stage of the cycle it was required.

Part 6, is the High Current Carrying Capacity cable, taking the current to the electrodes. As already stated, this will have to be thoroughly insulated and manufactured so that the generator is not connected when its terminals are exposed.

In FIG 1 (a), the piston is at the top of the cylinder, about to be pulled down by flywheel inertia and the inlet

valve is open to allow a cool charge of air to be drawn into the cylinder as the piston descends. Meanwhile, the rotor of the switch (5) is in exactly the opposite quadrant to the 'on' position. When the piston reaches the bottom of its stroke (b) the charge of air having been drawn into the cylinder, the inlet valve then closes.

The switch rotor has now progressed to the position adjacent to the 'on' position. Flywheel inertia again moves the piston causing it to rise and compress the charge. As the piston reaches the top of the cylinder again the switch rotor moves to the 'on' quadrant (c). This causes an arc to be struck between the two electrodes in the compressed air, causing it to heat up and expand rapidly, driving the piston down. As it does so, because one of the electrodes is positioned in the crown of the piston, the gap between the two electrodes lengthens causing the arc to lengthen correspondingly. This action results in a further rise in temperature and thus expansion, releasing further energy until such time that the gap is too long to sustain the arc and it collapses. By this time, the piston will be almost at the bottom of the power stroke (d), the switch rotor will have moved past the 'on' quadrant and the exhaust valve will open. Inertia of the flywheel will once again cause the piston to rise, expelling the now hot charge.

One of the practical difficulties would be that arcing would occur at the rotor switch as it moved towards and then away from the 'on' position. In a four cylinder engine, however, this could be overcome by making each quadrant and 'on' position for each cylinder, so that in fact, the current was never switched off.

Such an arrangement would make an ideal current distributor for a four cylinder engine. Similarly a two cylinder engine could have opposite quadrants as 'on' positions, though this would not solve the arcing problem. An engine having either three, or more than four, cylinders would need a separate distributor system. If the engine was made of electrically non conductive material and it proved to be too difficult to provide an earth return from the second 'in piston' electrode, then the alternative arrangement of two fixed electrodes as shown, for example in FIG 2 would have to be reverted to. This would mean however, that the advantages of the lengthening arc would be lost.

Another limiting factor would be the considerable build up of heat in the cylinders. Since the only openings into the

cylinders would be the inlet and exhaust ports, it could be difficult to dissipate.

The other difficulties would involve the arc itself. Firstly, it would of necessity be required to continually stop and start. Secondly, due to the critical timing factors of two and four stroke cycles it could never be struck before the air charge was compressed, and as stated previously, the compressed charge may act as an insulator to the electrical current. Similar problems could arise should the present invention be applied to rotary type engines such as the 'Wankel'. Nevertheless, with the advanced technology now available in electrical and electronic engineering, there is no reason why these problems should not be overcome, especially with the use of V.H.F./U.H.F. currents and atomised water spraying as stated previously.

With the gas turbine though, these problems are virtually eliminated by the working principles of the engine. In the first place, the engine is more 'open' and air passes through it in a continuous and uninterrupted stream. Moreover, up to 30% of the initially ingested air can be directed to bypass the complete compression/heat process and used as a cooling medium for the turbine blades, whilst still providing a limited contribution to the work done within the engine.

Secondly, unlike the piston engine, the arc once initially struck can be continuous, thus eliminating the stop/start problems. Possibly the greatest advantage of the gas turbine is that there is no reason why the arc cannot be commenced in normal atmospheric pressure, before compression is attained. This is because, with this type of engine, optimum compression is not reached until the compressor blades are being rotated by the starter at a predetermined minimum speed depending on the design of the engine. Thus, there is quite a few second time lag between the starter being operated and compression being attained.

There is no reason, however, why the arc could not be struck at the same instance as the starter is energised and remaining on while compression is built up. Therefore, the gas turbine principle automatically overcomes the problem of having to strike the arc in already compressed air. This does not mean though that the atomised water option could not be used if thought fit to do so, albeit that it may not be necessary.



The two main problems associated with current internal combustion gas turbines, which have so far inhibited their progress into the automotive field, are a comparatively high fuel consumption and slow acceleration. It is anticipated that the present invention would considerably reduce, if not eliminate, both problems the reason being, as we have already noted, because the electrical current acts directly on all the molecules, instead of 21% as in combustion, temperature rise and expansion would be both greater and more rapid. This would mean that less electrical energy pro rata would be required than comparable internal combustion systems. The rapid expansion would also result in greater acceleration when the strength of the arc was increased by an increase in the electric current, it is also anticipated that as the air charge is undergoing continuous linear and spiral motion in the gas turbine, the electric current will be able to affect a large number of compressed air molecules, thus producing a fairly large arc causing a high temperature, greater expansion and therefore releasing a high value of energy from the air charge.

It would therefore, appear, that not only could the present invention be more suited to the gas turbine rather than the piston engine but also the gas turbine would derive more efficiency from the present invention than the internal combustion process.

FIG 4 shows a section through a possible layout for a gas turbine incorporating the present invention. Although this particular example shows a combination of axial flow compressors and turbines, there is no reason why radial turbines or compressors, or a combination of both should not be used.

A three stage compressor (cc) is mounted at one end of a shaft and a two stage power turbine (pt) at the other so that both compressor and power turbine rotate in unison. The third stage slave turbine (st) rotates on a separate shaft which also forms part of a reduction gear 7. Parts 1 (a pair are shown) protrude into the centre of the engine through both the outer and inner casing. Parts 2 (pair also shown) are mounted on a stationary centre core through the centre of which is placed the main shaft for the Compressor/Power turbine assembly. The support pillars of the centre core have been cut away in order to show the direction of the primary air charge. The secondary air charge travels along the passage created between the two casings. Part 3, the V.H.F./U.H.F. generator or supply current and Part 4, the governor - variable resistor

throttle control are also mounted on the engine and shown in the bottom right hand corner of the drawing.

From here the current is taken directly to initial electrodes (1) via a pair of cables (6). There is no need for Part 5 the switch device since as we have already seen, the gas turbine principle does not need the arc to be either switched on-and-off, or distributed.

When the Compressor/Power turbine is initially rotated by the starter air is drawn in through the first stage of the compressor. Then some of it will be directed into the outer passage bypassing the interior of the engine and be blown directly onto the outer tips of the turbine blades, this will act as a coolant. The majority of the air however, will pass through the second and third stages of the compressor and thus compressed will flow around the tips of the electrodes (1 & 2) which by this time, the current having already been applied, will be supporting an arc. This will cause the air to heat up and increase in volume. As it does so, it will flow through the Power turbine blades and continue the rotation of the compressor shaft. There will though still be a large amount of energy left in the air as it expands through the slave turbine which it will rotate. Because the rotating speed of a turbine is often tens of times higher than the crankshaft of a corresponding piston unit, it is anticipated that the reduction gear assembly (7) will be required for certain applications. Finally the hot air is expelled through the rear of the engine, being deflected as and if necessary. Acceleration/deceleration could be achieved by the variable resistor (4) coupled to a governor as previously described for the piston engine.

So far it has been shown how, the present invention could be applied to energise an inert gas as a working fluid or heat transporter. It will now be shown how it may be applied to an inert liquid such as water. It is already widely known that electric arc welding can be carried out directly under water and that an envelope of steam is created around the work area, although this is usually cooled and condensed without any of its potential energy being realised, because the operation is nearly always carried out in volumes of water large enough to absorb the heat produced. If, however, the arcing process was carried out inside a vessel of a relatively small volume so that, the steam generated could remain as steam and be directed through a device, (e.g. cylinder/piston or turbine) to

extract the potential energy from it, then useful work could be done.

Figure 5 shows such an arrangement and illustrates a vessel inside which, at one end rotates an impellar (Im) and at the other a compound turbine (T-1 T-2) both on a common shaft. As the impellar rotates, water is drawn in and directed towards the two pairs of electrodes (1 & 2) which are supporting an arc, in a similar manner to that previously described for the gas turbine version. These convert the water into steam which then expands. As it does so it passes through and then rotates the compound turbines which in turn, because they are mounted on the same shaft, rotate the impellar. The electrical current required to sustain the arc is supplied similarly to the previous examples shown in the present invention though because water is a good conductor of electricity it may not be necessary to produce a V.H.F./U.H.F. current. Though V.H.F. /U.H.F. currents may be able to exploit more energy than sinusoidal currents. A device of this type could be used to power a submarine or heart and circulate water through a central heating system.

So far the description of the present invention has shown how the agitation of the molecules of a working fluid can be caused by an electric arc. It would be possible also to produce similar agitation by passing various types of electrically produced waves through the fluid similar to those used in modern day cooking, but the resulting agitation would not be so rapid or dramatic as that produced by the arc.

Laser Beams, however, may not only produce rapid and vigorous agitation similar to the electric arc, but also be created to cause the fluid's molecules to behave in patterns that would release the maximum amount of kinetic energy. They could, therefore, be adapted to be used in a similar manner to that of the electric arc, as described in the present invention.

Either D.C. (direct current) or A.C. (alternating current) could be used but it may well prove to be the case that, A.C. current would be better since it would discourage the process whereby electrons would leave one electrode and eventually build up on the other.

The primary objective of the present invention has been to energise an inert working fluid. It could appear, however, that the electric arc used, would be of sufficiently high temperature to reduce potentially toxic gasses and /or liquids to a safer state. Such materials may not always, however, be inert. For instance, harmful gasses normally produced by burning certain plastics and foams could be fed into a device similar to the ones previously described and thus made safer. The object of this part of the invention though is not to extract further energy but to make the material safer and less toxic.

The present invention represents a completely new, and hitherto untried field of energy production and there may well be additions which the energy produced would sustain. For example, it is possible that devices called 'ionisers' could be added to the exhaust outlet of an engine incorporating this invention. Such devices would greatly enhance the properties of the exhaust emission and thus improve the environment.

## CLAIMS

### WHAT I CLAIM IS:

1. An alternative method to either combustion or nuclear reaction of heating or energising a working fluid. The fluid may be in either liquid or gaseous or in some cases, solid state and may change from one form to another during the energising process. The fluid must at all times though be inert, except in the case of, Claim six.
2. An electrically or electronically induced arc, various types of electrically produced waves, laser beam or similar medium to be used to energise the working fluid in Claim 1.
3. The current required to produce the electrical/electronic medium in Claim 2, may be produced either by a generator powered by the device used in the process, or from an external source or a combination of both.
4. In order to improve the electrical conductivity of the working fluid in Claim 1, a substance with good electrical conductivity properties may be added e.g. atomised water to compressed air.
5. The current required in Claim 3, may need to vary according to the electrical conductivity properties in Claim 1 and could therefore be either Sinusoidal, Very High Frequency/Ultra High Frequency or any other A.C. currents (i.e. Alternating Current) but in some cases D.C. (Direct), currents may also be adopted. The amperage and voltage of these currents will vary, both with the differing types of device used and according to the varying power demanded by each engine or device.
6. Potentially toxic materials could be transformed to safer substances by one of the mediums in Claim 2.
7. Additional improvements may be made within the scope of this invention by adding, for example, ionisers in the exhaust emission area in order to improve the quality of the exhaust emission for environmental purposes.

